

Diabetic Kidney Disease

National Diabetes Information Clearinghouse



What is diabetic kidney disease?

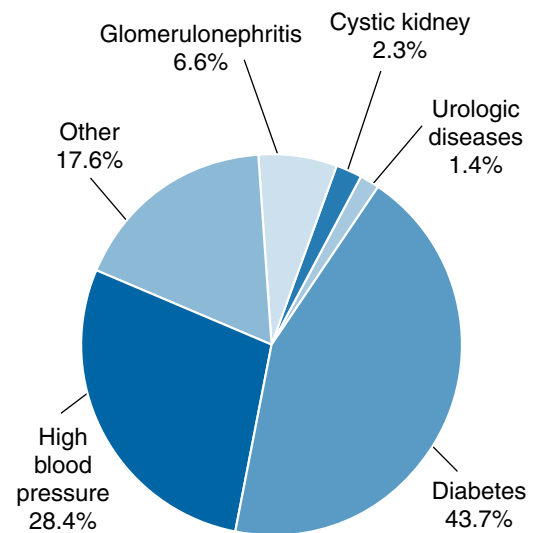
Diabetic kidney disease, also called diabetic nephropathy, is kidney disease caused by diabetes. Even when well controlled, diabetes can lead to chronic kidney disease (CKD) and kidney failure, described as end-stage kidney disease or ESRD when treated with a kidney transplant or blood-filtering treatments called dialysis.

Diabetes affects 25.8 million people of all ages in the United States.¹ As many as 40 percent of people who have diabetes are expected to develop CKD.² Diabetes, the most common cause of kidney failure in the United States, accounts for nearly 44 percent of new cases of kidney failure, as illustrated in Figure 1.³

What are the kidneys and what do they do?

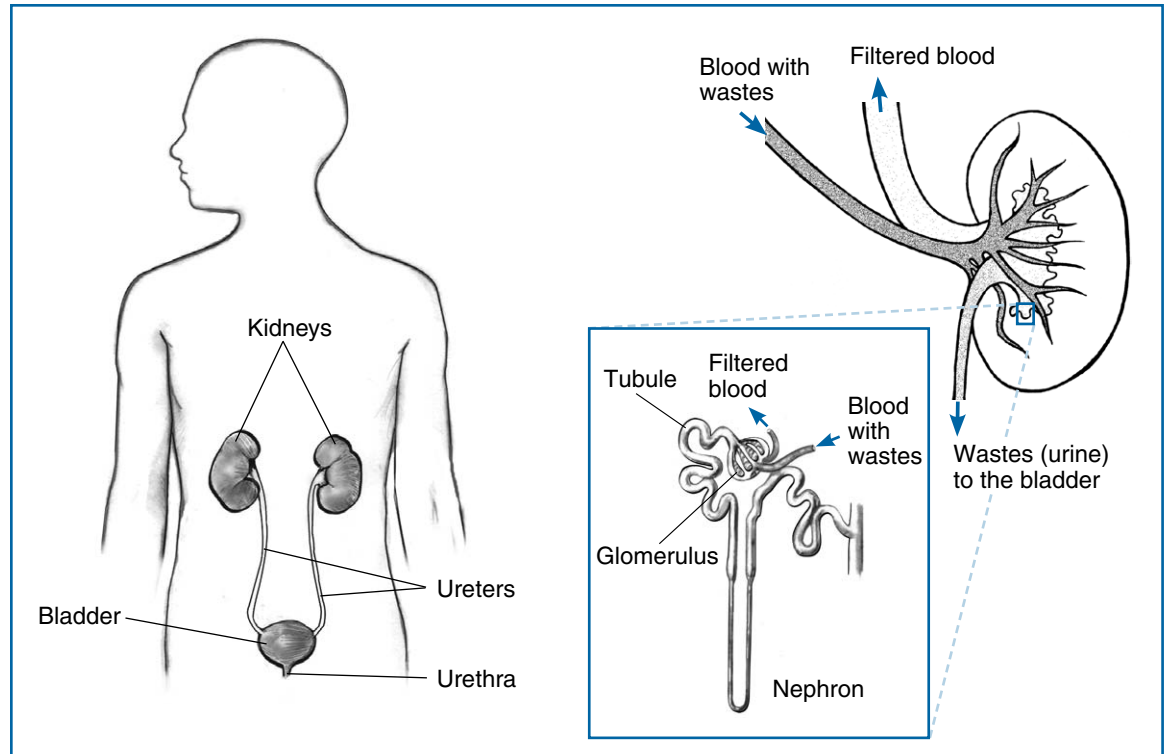
The kidneys are two bean-shaped organs, each about the size of a fist. They are located just below the rib cage, one on each side of the spine. Every day, the two kidneys filter about 120 to 150 quarts of blood to produce about 1 to 2 quarts of urine, composed of wastes and extra fluid. The urine flows from the kidneys to the bladder through tubes called ureters. The bladder stores urine.

Figure 1. Causes of kidney failure in the United States



Source: Health, United States, 2011: table 51. End-stage renal disease patients, by selected characteristics: United States, selected years 1980–2010. Centers for Disease Control and Prevention website. www.cdc.gov/nchs/data/hsr/2011/051.pdf. Updated 2011. Accessed July 21, 2014.

When the bladder empties, urine flows out of the body through a tube called the urethra, located at the bottom of the bladder. In men the urethra is long, while in women it is short.



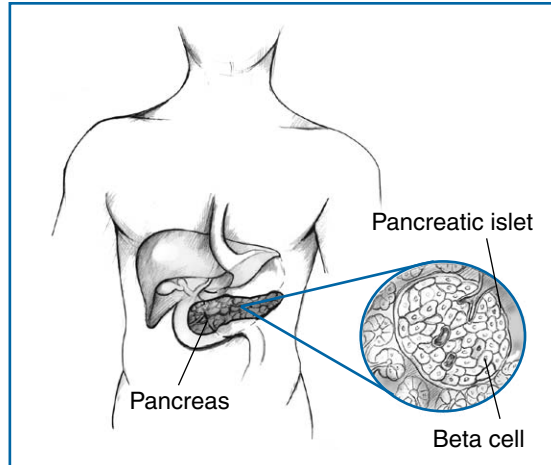
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Kidneys work at the microscopic level. The kidney is not one large filter. Each kidney is made up of about a million filtering units called nephrons. Each nephron filters a small amount of blood. The nephron includes a filter, called the glomerulus, and a tubule. The nephrons work through a two-step process. The glomerulus lets fluid and waste products pass through it; however, it prevents blood cells and large molecules, mostly proteins, from passing. The filtered fluid then passes through the tubule, which sends needed minerals back to the bloodstream and removes wastes. The final product becomes urine.

What is diabetes?

Diabetes is a complex group of diseases with a variety of causes. People with diabetes have high blood glucose, also called high blood sugar or hyperglycemia.

Diabetes is a disorder of metabolism—the way the body uses digested food for energy. The digestive tract breaks down carbohydrates—sugars and starches found in many foods—into glucose, a form of sugar that enters the bloodstream. With the help of the hormone insulin, cells throughout the body absorb glucose and use it for energy.



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Insulin is made in the pancreas, an organ located behind the stomach and below the liver. As blood glucose levels rise after a meal, the pancreas is triggered to release insulin. The pancreas contains clusters of cells called pancreatic islets. Beta cells within the pancreatic islets make insulin and release it into the blood.

Diabetes develops when the body doesn't make enough insulin, is not able to use insulin effectively, or both. As a result, glucose builds up in the blood instead of being absorbed by cells in the body. The body's cells are then starved of energy despite high blood glucose levels.

How does diabetes lead to kidney disease?

Diabetes leads to kidney disease in several ways. At the onset of diabetes, blood flow into the kidneys increases, which may strain the glomeruli and lessen their ability to filter blood. Higher levels of blood glucose lead to the buildup of extra material in the glomeruli, which increases the force of the blood moving through the kidneys and creates stress in the glomeruli. This stress leads to gradual and progressive scarring of the glomeruli, eventually reducing the kidneys' ability to filter blood properly. Other factors—including heredity, diet, lifestyle, and other medical conditions—are also involved in the development of kidney disease, though scientists cannot fully explain how the interaction of these factors leads to diabetic kidney disease.

Many people with diabetes can develop high blood pressure, another factor in the development of kidney disease. High blood pressure, also called hypertension, is an increase in the amount of force that blood places on blood vessels as it moves through the entire body. When the force of blood flow is high, blood vessels stretch so blood flows more easily. Eventually, this stretching scars and weakens blood vessels throughout the body, including those in the kidneys.

Read more in *High Blood Pressure and Kidney Disease* at www.kidney.niddk.nih.gov.

How does diabetic kidney disease progress?

Diabetic kidney disease takes many years to develop. High levels of blood glucose cause the kidneys to filter blood at a higher rate than normal. Over time, the stress on the kidneys can decrease their ability to filter blood normally.

Albumin, the main protein found in blood, normally remains in the bloodstream. When the kidneys' filtering units are damaged, albumin may be able to pass through the filter and into the urine. A slightly increased level of albumin in the urine is an early sign of diabetic kidney disease and the first stage of CKD. The kidneys' ability to filter blood typically remains normal during this stage.

As CKD progresses, more albumin leaks out of the blood and into the urine, and it becomes more difficult for the kidneys to excrete water and salt. As a result, a person may

- hold more salt in the body
- hold various wastes in the body
- have higher blood pressure
- experience swelling of the legs caused by extra fluid in the body

What are the symptoms of diabetic kidney disease?

People with diabetic kidney disease do not have symptoms in the early stages. As kidney disease progresses, a person can develop edema, or swelling. Edema happens when the kidneys cannot get rid of the extra fluid and salt in the body. Edema can occur in the legs, feet, or ankles and less often in the hands or face. Once kidney function decreases further, symptoms may include

- appetite loss
- nausea
- vomiting
- drowsiness, or feeling tired
- trouble concentrating
- sleep problems
- increased or decreased urination
- generalized itching or numbness
- dry skin
- headaches
- weight loss
- darkened skin
- muscle cramps
- shortness of breath
- chest pain

How is diabetic kidney disease diagnosed?

A health care provider diagnoses diabetic kidney disease based on

- a medical and family history
- a physical exam
- urine tests
- a blood test

Medical and Family History

Taking a medical and family history is one of the first things a health care provider may do to help diagnose diabetic kidney disease. He or she will ask about the symptoms and the patient's diabetes history.

Physical Exam

After taking a medical and family history, a health care provider will perform a physical exam. During a physical exam, a health care provider usually

- examines the patient's body to check for changes in skin color
- taps on specific areas of the patient's body, checking for swelling of the feet, ankles, or lower legs

Urine Tests

Dipstick test for albumin. A dipstick test performed on a urine sample can detect the presence of albumin in the urine. A patient collects the urine sample in a special container in a health care provider's office or a commercial facility. The office or facility

tests the sample onsite or sends it to a lab for analysis. For the test, a nurse or technician places a strip of chemically treated paper, called a dipstick, into the urine. Patches on the dipstick change color when blood or protein is present in urine.

Urine albumin-to-creatinine ratio. A health care provider uses this measurement to estimate the amount of albumin passed into the urine over a 24-hour period. The patient collects a urine sample during an appointment with the health care provider. Creatinine is a waste product that is filtered in the kidneys and passed into the urine. A high urine albumin-to-creatinine ratio indicates that the kidneys are leaking large amounts of albumin into the urine. A urine albumin-to-creatinine ratio above 30 mg/g may be a sign of kidney disease.

Blood Test

A blood test involves having blood drawn at a health care provider's office or a commercial facility and sending the sample to a lab for analysis. A health care provider may order a blood test to estimate how much blood the kidneys filter each minute, called the estimated glomerular filtration rate (eGFR). The results of the test indicate the following:

- eGFR of 60 or above is in the normal range
- eGFR below 60 may indicate kidney damage
- eGFR of 15 or below may indicate kidney failure

Get Screened for Kidney Disease

People with diabetes should get regular screenings for kidney disease. The National Kidney Disease Education Program recommends the following:

- urine albumin-to-creatinine ratio measured at least once a year in all people with type 2 diabetes and people who have had type 1 diabetes for 5 years or more
- eGFR calculated at least once a year in all people with type 1 or type 2 diabetes

How can people prevent or slow the progression of diabetic kidney disease?

People can prevent or slow the progression of diabetic kidney disease by

- taking medications to control high blood pressure
- managing blood glucose levels
- making changes in their eating, diet, and nutrition
- losing weight if they are overweight or obese
- getting regular physical activity

People with diabetes should see a health care provider who will help them learn to manage their diabetes and monitor their diabetes control. Most people with diabetes get care from primary care providers, including internists, family practice doctors, or pediatricians. However, having a team of health care providers can often improve diabetes care. In addition to a primary care provider, the team can include

- an endocrinologist—a doctor with special training in diabetes
- a nephrologist—a doctor who specializes in treating people who have kidney problems or related conditions
- diabetes educators such as a nurse or dietitian
- a podiatrist—a doctor who specializes in foot care
- an ophthalmologist or optometrist for eye care
- a pharmacist
- a dentist
- a mental health counselor for emotional support and access to community resources

The team can also include other health care providers and specialists.

Blood Pressure Medications

Medications that lower blood pressure can also significantly slow the progression of kidney disease. Two types of blood pressure-lowering medications, angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARBs), have been shown to slow the progression of kidney disease. Many people require two or more medications to control their blood pressure. In addition to an ACE inhibitor or an ARB, a health care provider may prescribe a diuretic—a medication that helps the kidneys remove fluid from the blood. A person may also need beta-blockers, calcium channel blockers, and other blood pressure medications.

People should talk with their health care provider about their individual blood pressure goals and how often they should have their blood pressure checked.

Managing Blood Glucose Levels

People manage blood glucose levels by

- testing blood glucose throughout the day
- following a diet and physical activity plan
- taking insulin throughout the day based on food and liquid intake and physical activity

People with diabetes need to talk with their health care team regularly and follow their directions closely. The goal is to keep blood glucose levels within the normal range or within a range set by the person's health care team. Read more about diabetes in these publications at www.diabetes.niddk.nih.gov:

- *National Diabetes Statistics Report, 2014*
- *Diagnosis of Diabetes and Prediabetes*

Eating, Diet, and Nutrition

Following a healthy eating plan can help lower blood pressure and control blood sugar. A health care provider may recommend the Dietary Approaches to Stop Hypertension (DASH) eating plan. DASH focuses on fruits, vegetables, whole grains, and other foods that are heart healthy and lower in sodium, which often comes from salt. The DASH eating plan

- is low in fat and cholesterol
- features fat-free or low-fat milk and dairy products, fish, poultry, and nuts
- suggests less red meat, and fewer sweets, added sugars, and sugar-containing beverages
- is rich in nutrients, protein, and fiber

Read more about DASH at www.nhlbi.nih.gov/health/health-topics/topics/dash.

People with diabetic kidney disease may need to limit sodium and salt intake to help reduce edema and lower blood pressure. A dietitian may also recommend a diet low in saturated fat and cholesterol to help control high levels of lipids, or fats, in the blood.

Health care providers may recommend that people with CKD eat moderate or reduced amounts of protein, though the benefits of reducing protein in a person's diet are still being researched. Proteins break down into waste products the kidneys must filter from the blood. Eating more protein than the body needs may burden the kidneys and cause kidney function to decline faster. However, protein intake that is too low

may lead to malnutrition, a condition that occurs when the body does not get enough nutrients. Read more about diabetes and diet in the following publications:

- *What I need to know about Eating and Diabetes* and *What I need to know about Carbohydrate Counting and Diabetes* at www.diabetes.niddk.nih.gov.
- *Make the Kidney Connection: Food Tips and Healthy Eating Ideas* and *Eating Right for Kidney Health: Tips for People with Chronic Kidney Disease* at www.nkdep.nih.gov.

Weight Loss and Physical Activity

Health care providers recommend that people who are overweight or obese lose weight to improve their bodies' ability to use insulin properly and lower their risk for health problems related to high blood pressure. Overweight is defined as a body mass index (BMI)—a measurement of weight in relation to height—of 25 to 29. A BMI of 30 or higher is considered obese. People should aim to keep their BMI lower than 25.⁴

Experts recommend physical activity as an important part of losing weight, keeping sensitivity to insulin, and treating high blood pressure. Most people should try to get at least 30 to 60 minutes of activity most or all days of the week. A person can do all physical activity at once or break up activities into shorter periods of at least 10 minutes each. Moderate activities include brisk walking, dancing, bowling, riding a bike, working in a garden, and cleaning the house. Read more in *What I need to know about Physical Activity and Diabetes* at www.diabetes.niddk.nih.gov.

How is kidney failure due to diabetic kidney disease treated?

A health care provider may treat kidney failure due to diabetic kidney disease with dialysis or a kidney transplant. In some cases, people with diabetic kidney disease receive kidney and pancreas transplants.

In most cases, people with diabetic kidney disease start dialysis earlier than people with kidney failure who do not have diabetes. People with diabetic end-stage kidney disease who receive a kidney transplant have a much better survival rate than those people on dialysis, although survival rates for those on dialysis have increasingly improved over time. However, people who receive a kidney transplant and do not have diabetes have a higher survival rate than people with diabetic kidney disease who receive a transplant.⁵

Read more about treatment options for kidney failure in these publications at www.kidney.niddk.nih.gov:

- *Treatment Methods for Kidney Failure: Hemodialysis*
- *Treatment Methods for Kidney Failure: Peritoneal Dialysis*
- *Treatment Methods for Kidney Failure: Transplantation*

Work with the Health Care Team to Manage Diabetes and Chronic Kidney Disease

People with diabetes should work with their health care team to prevent or manage CKD through the following steps:

- measure A1C levels—a blood test that provides information about a person’s average blood glucose levels for the previous 3 months—at least twice a year and keep A1C levels below 7 percent
- learn about insulin injections, diabetes medications, meal planning, physical activity, and blood glucose monitoring
- find out whether protein, salt, or liquid should be limited in the diet
- see a registered dietitian to help with meal planning
- check blood pressure every visit with a health care provider or at least two to four times a year
- learn about possible benefits from taking an ACE inhibitor or an ARB if a person has high blood pressure
- measure eGFR at least once a year to check kidney function
- get the amount of protein in the urine tested at least once a year to check for kidney damage

Points to Remember

- Diabetic kidney disease, also called diabetic nephropathy, is kidney disease caused by diabetes.
- People with diabetes have high blood glucose, also called high blood sugar or hyperglycemia.
- At the onset of diabetes, blood flow into the kidneys increases, which may strain the glomeruli and lessen their ability to filter blood.
- Higher levels of blood glucose lead to the buildup of extra material in the glomeruli, which increases the force of the blood moving through the kidneys and creates stress in the glomeruli.
- Many people with diabetes can develop high blood pressure, another factor in the development of kidney disease. High blood pressure, also called hypertension, is an increase in the amount of force that blood places on blood vessels as it moves through the entire body.
- Diabetic kidney disease takes many years to develop.
- People with diabetic kidney disease do not have any symptoms in the early stages. As kidney disease progresses, a person can develop edema, or swelling. Edema happens when the kidneys cannot get rid of the extra fluid and salt in the body. Edema can occur in the legs, feet, or ankles and less often in the hands or face.

- Once kidney function decreases further, symptoms may include
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- People can prevent or slow the progression of diabetic kidney disease by
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 - managing blood glucose levels
 - making changes in their eating, diet, and nutrition
 - losing weight if they are overweight or obese
 - getting regular physical activity

Hope through Research

In recent years, researchers have learned much about kidney disease. The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) sponsors many programs aimed at better understanding all types of kidney disease, including diabetic kidney disease.

Family Investigation of Nephropathy and Diabetes (F.I.N.D.), funded under National Institutes of Health (NIH) clinical trial number NCT00342927, aims to identify genetic determinants of diabetic kidney disease. Genetic testing is conducted on samples from people with diabetes and their parents and siblings to better understand how kidney disease develops. Improving Evidence-Based Primary Care for Chronic Kidney Disease, funded under NIH clinical trial number NCT01767883, evaluates how primary care physicians treat CKD and then uses that information to develop evidence-based practice guidelines for health care providers to follow when treating a person with CKD.

Clinical trials are research studies involving people. Clinical trials look at safe and effective new ways to prevent, detect, or treat disease. Researchers also use clinical trials to look at other aspects of care, such as improving the quality of life for people with chronic illnesses. To learn more about clinical trials, why they matter, and how to participate, visit the NIH Clinical Research Trials and You website at www.nih.gov/health/clinicaltrials. For information about current studies, visit www.ClinicalTrials.gov.

Read more about the NIDDK's research on diabetes and related topics at www.diabetes.niddk.nih.gov/diabetesresearch/dm_research.aspx.

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For More Information

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This publication may contain information about medications and, when taken as prescribed, the conditions they treat. When prepared, this publication included the most current information available. For updates or for questions about any medications, contact the U.S. Food and Drug Administration toll-free at 1-888-INFO-FDA (1-888-463-6332) or visit www.fda.gov. Consult your health care provider for more information.



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